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# ANNUAL ORATION

DELVIERED BEFORE THE

CHEMICAL SOCIETY OF PHILADELPHIA;

APRIL 11th, 1798.

BRITISH MUSEUM

# A SKETCH OF THE REVOLUTIONS IN CHEMISTRY.

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By THOMAS P. SMITH.

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BRITISH MUSEUM

To ROBERT PATTERSON, A. M.

PROFESSOR OF MATHEMATICS IN THE UNIVERSITY OF PENNSYLVANIA.

SIR,

I KNOW no perſon to whom my firſt eſſay can be DEDICATED with ſo much propriety as to the inſtructor of my early youth. Accept it then as a ſmall, but ſincere, tribute of gratitude, from

*Your friend*
*and pupil,*

THOMAS P. SMITH.

PHILADELPHIA LABORATORY,

APRIL 14th, 1798.

*In meeting of the Chemical Society of Philadelphia,*

*RESOLVED*—That a copy of Mr. Smith's learned and ingenious Oration be requeſted for publication.

Extract from the minutes,

GEORGE LEE,

Jun. Sec'ry.

# INTRODUCTION.

*Gentlemen of the Chemical Society,*

HAVING been honoured by you with the appointment to deliver the ANNUAL ORATION, I have, with diffidence, prepared myſelf to comply with your requeſt. I ſhall not attempt to apologize for any imperfections it may contain, however numerous they may be, as they are the inevitable effects of your choice. But there is one liberty I have taken, for which I conſider myſelf bound to apologize.

The *Reſolution*, in purſuance of which this oration is delivered, directs that it ſhall contain all the diſcoveries made in the ſcience of chemiſtry during the preceding year. Inſtead of complying with the *letter* of this reſolution, I have taken the liberty of preparing for you *a ſketch of the revolutions in chemiſtry*. To this I have been induced from a conſideration of the utility and pleaſure that always reſult from a knowledge of the origin of our opinions. He who ſhould take up his abode on the banks of a ſtream, and quench his thirſt from its waters, could not feel unintereſted in a knowledge of its ſource, and the courſe it has run. Knowing over what ſubſtances its waters have paſſed, he is enabled in ſome meaſure to judge of their purity, and is put on his guard againſt any bad effects that may be produced by them. Thus, by knowing the origin of our opinions and the channels through which they have come to us, we can form a tolerable judgment of what particular prejudices they are moſt likely to be biaſſed by, and be thus put on our guard againſt receiving them without the ſtricteſt examination. Such were the reaſons which induced me to write, and which I hope will induce you to pardon me for delivering before you, A SKETCH OF THE REVOLUTIONS IN CHEMISTRY.

# A

# SKETCH, &c.

THE origin of CHEMISTRY, like the origin of every other ſcience that early dawned upon mankind, lies buried beneath the dark fables of antiquity. The aſcription of the diſcovery of truths, or the invention of arts, beneficial to mankind, to ſupernatural beings, was ſo general during thoſe dark ages of ignorance and ſuperſtition, that we are not to wonder that the ſcience of chemiſtry was ſuppoſed to have had a divine origin.

If muſic, poetry, and painting; if the arts of making wine, raiſing grain, healing the ſick, had their tutelary deities who were ſuppoſed to have taught them to man, if the Egyptian, when he beheld the Nile, without any apparent cauſe to him, who was ignorant of its ſource, periodically overflow its banks, fertilize his land, and then peaceably retire within its proper limits, ſuppoſed it to deſcend from heaven, ſhould we not expect that chemiſtry, a ſcience to which almoſt all others owe their birth, would have been ſuppoſed to have been derived from the GODS, Accordingly we find this to be the prevailing opinion of the ancients. But however intereſting an inveſtigation of theſe fables may be to ſuch as imagine them allegorical accounts of the origin of chemiſtry, we muſt paſs them over as the unmeaning offspring of IGNORANCE and SUPERSTITION.

Were we to endeavour to ſearch out the true origin of chemiſtry, we ſhould find ourſelves bewildered to little or no purpoſe among the multifarious traditions of antiquity; like the traveller who ſhould in vain attempt to aſcertain the true ſource of a great river, formed by the union of a number of ſmall ſtreams, we ſhould after much labour and diſappointment give up the purſuit as one in which the effect produced would not repay us for the labour endured.

The Arabians appear to have been the firſt people who made any conſiderable progreſs in chemiſtry. For however great the extent of knowledge in this ſcience the votaries of antiquity may aſcribe to the Egyptians, we cannot conſider them as having made any great progreſs in it. It is true they had carried ſome of the practical parts of it, ſuch as, the working of metals, imitating precious ſtones, and painting on glaſs, to a conſiderable degree of perfection; yet they do not appear to have poſſeſſed any knowledge of its general principles. It was as yet confined to the forge of the *ſmith* and the work-ſhop of the *lapidary*; and they expected their proceſſes to terminate favourably only becauſe their predeceſſors, who perhaps were taught by ſome happy accident, promiſed them ſucceſs. Their prieſts, indeed, pretended to extenſive knowledge in this as well as in every other ſcience, but as they have left us no data by which we can judge of their knowledge, we are led to believe that in theſe pretenſions, as well as in thoſe to great ſanctity, their object was merely to gain an aſcendency over weak minds. The ſimpleſt ideas repreſented by their hieroglyphick characters were converted by the eye of IGNORANCE, who venerates every thing ſhe does not underſtand, into the moſt ſublime truths. Hence aroſe the idea that theſe prieſts, who perhaps underſtood little more than how to delude a ſuperſtitious, ignorant people, were poſſeſſed of a knowledge of all the arcana of nature.

Nor need we be ſurpriſed that this was the caſe in thoſe dark ages, when even in this enlightened century men are found weak enough to ſpend their time in the ſolution of ancient fables, in ſearch of truths which are only to be diſcovered by contemplating the works of nature, and who have the effrontery to declare that in theſe puerilities they can eaſily diſcern that the ancients were poſſeſſed of a knowledge of almoſt all that the moderns have thought themſelves the diſcoverers. So far, indeed, has this blind attachment to antiquity been carried that it need not excite your ſurpriſe, if ſome one of theſe *fabulous commentators*, more deeply learned than his fellow labourers, ſhould by means of a ſmoaking chalice found on the pillar of Trajan, transfer from LAVOISIER to an Egyptian prieſt the honour of the pneumatic theory; or, by the bowl of the ſacrifice overflowing with blood, painted on a Mummy, deprive PRIESTLEY of the honour of the diſcovery of the oxigination of the blood.

To the Arabians, then, is to be aſcribed the honour of being the firſt nation in which chemiſtry ceaſed to be nothing more than a knowledge of a few proceſſes in the arts confined to the work-ſhops of illiterate mechanics. To this nation we are indebted for its application to medicine which was firſt effected in the tenth century by Rhaſes a phyſician of the hoſpital of Bagdad. It now became an object worthy the attention of men of letters and genius. The phœnomena of nature were ſcrutinized with an attentive eye, new proceſſes were inſtituted for determining her laws, and bodies before ſuppoſed *ſimple*, were analized by means of newly diſcovered agents. Such was the ſituation of chemiſtry in Arabia, when by means, apparently little favourable to the diſſemination of ſcience, it was tranſplanted into the weſt of Europe.

Towards the cloſe of the eleventh century all *Chriſtendom* was rouſed to arms by the declamation of an obſcure individual of the name of Peter, ſirnamed the Hermit. This man, who to the moſt barbarous ferocity added the moſt refined cunning, travelled over Europe preaching up a *croiſade* to recover from the hands of the *infidels* the *holy-land*. As his hearers were plunged in the moſt barbarous ignorance, their paſſions were eaſily wrought upon, and this man who in the eighteenth century would be confined in a *mad-*

*houſe*, or treated with contempt, in the eleventh raiſed an army of 700,000 men to effect his abſurd ſcheme. This army of which BIGOTRY and SUPERSTITION led the van, and MURDER and RAPINE cloſed the rear, was compoſed of men of every rank and profeſſion. And this army, however unfit a medium it may appear for the tranſmiſſion of ſcience, was the means by which chemiſtry was firſt tranſplanted into Europe.

That men actuated by ſuch motives as the croiſaders were, who, with the ſymbols of peace in one hand, and a reeking ſword in the other, marked their footſteps with the blood of women and children; who had left their peaceful habitations, their wives, their children and all the joys of domeſtic happineſs, to enforce by the ſword the truth of a religion whoſe baſis is charity, and to wreſt from the hands of *infidels*, in another quarter of the world, a barren tract of land almoſt unfit for the habitation of man, becauſe it was the birth place of their religion; that theſe men ſhould be the diſſeminators of ſcience, is a paradox in the hiſtory of the human mind that at firſt view appears inexplicable. But the difficulty vaniſhes when we recollect, that, happily for the cauſe of ſcience, the chemiſtry of the Arabians was deeply tinged with alchemical notions*. The croiſaders who were blind to the charms of ſcience, were far from being ſo to thoſe of gold. As ſoon, therefore, as chance threw in their way pretenders to the art of converting the metals, their avarice was rouſed, and for the ſake of the promiſed wealth they *condeſcended* to ſtudy chemiſtry. After the defeat of this immenſe army, many, who had ſet off with a deſign of converting the *infidels* to *Chriſtianity* by means of the ſword, returned to endeavour to convert all the metals into gold by means of their newly acquired chemical agents.

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* See note A. at the end.

Europe ſoon ſwarmed with people in ſearch of the agent, by means of which the baſer metals were to be converted into gold and ſilver, and to which they had given the name of the Philoſopher's-ſtone. All claſſes of people were ſeized with the mania. The indigent man, who was inſtigated to ſtudy by the hopes of acquiring wealth, but who for want of money to commence his operations was unable to proceed, was ſure to find a patron among the wealthy, who upon the condition of ſharing in the diſcovery, advanced large ſums of money for carrying on the operations. Proceſſes of the moſt extenſive and expenſive nature were inſtituted in ſearch of this chimerical ſubſtance, and the moſt important diſcoveries, though different from that moſt hoped for, were made. No expence of labour or time was ſpared, and immenſe fortunes were diſſipated by men who would not have advanced the ſmalleſt ſum for the diſcovery of any truth whatever from which they could not hope to derive ſome pecuniary advantage. Thus was avarice enliſted in the cauſe of ſcience, and thus that worſt paſſion of the human breaſt, which has ever, but at this ſingle period, retarded the progreſs of ſcience, now tended in the moſt aſtoniſhing manner to its promotion.

That branch of chemiſtry called mineralurgy, particularly flouriſhed during theſe reſearches. The metals were the objects to which the attention of the alchemiſts was immediately directed. Hence conſiderable progreſs was made in the art of extracting them from their ores and working them.

From an idea entertained by ſome of the alchemiſts that the philoſopher's-ſtone was to be the reſult of an intimate union of *ſulphur* and *mercury*, this ſemimetal became in a peculiar manner the object of their attention. The reſult was that the materia medica became enriched with many invaluable preparations of it.

This period gave birth to a number of men of the moſt reſpectable talents; at the head of theſe we muſt rank Roger Bacon, who flouriſhed in the thirteenth century, and whoſe mind was deeply tinged with alchemical notions.

In the courſe of ſome chemical experiments, Bacon having mixed nitre, ſulphur and charcoal together, in a mortar, they by accident took fire and produced a loud exploſion, this firſt ſuggeſted to him the idea of making gun-powder, which, from a falſe idea he entertained of the terrible effects that would be produced by its being generally known, he concealed in his writings under the form of an anagram.

In the ſixteenth century a new ſect of alchemiſts appeared, who were in ſeach of a medicine that ſhould cure all diſeaſes.

The Arabians in their treatiſes on alchemy, had employed that figurative language which is ſo univerſal in the Eaſt. The agents they uſed for bringing metals to *perfection* they called *medicines*, the *imperfect* metals *ſick men*, and gold *a ſound*, *lively*, *healthy*, *durable man*. When the Europeans procured tranſlations of theſe works many of them underſtood all theſe figurative expreſſions in a literal ſenſe, and when in the courſe of their reading they met with paſſages like the following from Geber, "*Gold thus prepared cures lepras*, *cures all diſeaſes*," and in which he only meant it would tranſmute all the other metals into gold, they underſtood it to be a medicine by which all the diſeaſes to which the human frame is liable might be cured*. Such was the origin of a ſect of alchemiſts to whoſe induſtry we are indebted for the moſt valuable acceſſions to the materia medica.

At the head of this ſect of alchemiſts ſtood Paracelſus, a name familiar to every chemiſt. He was born near Zurick in Swiſſerland, in 1493. From his earlieſt youth he ſeems to have poſſeſſed all that wildneſs of imagination which ſo ſtrongly characterizes his countrymen. The moment he conceived a thing poſſible, he formed a theory for the performance of it, and then proclaimed to the world he had effected it. As ſoon, therefore, as he conceived of the poſſibility of forming a *panacea*, he commenced his ſearch after it, and emboldened by the ſucceſs of ſome of his mercurial preparations he declared he poſſeſſed the power of cloſing forever the door of the tomb.

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* Boerhaave.

Having likewiſe formed an idea of a liquor that ſhould diſſolve every ſubſtance in nature, and to which he gave the name of the *alcaheſt*, he declared to the world he had diſcovered it, and publiſhed a book in which he gave an account of many of its operations. This book abounds with the wildeſt extravagances and moſt palpable contradictions. In ſeveral paſſages of it he tells us of his having diſſolved various ſubſtances in the *alcaheſt*, in veſſels hermetically ſealed, in which operations although the ſubſtances were readily diſſolved, the veſſels appear to have remained undiſſolved by this univerſal ſolvent. Van Helmont has likewiſe written much on *the alcaheſt*, and has the effrontery to declare that he poſſeſſed for a conſiderable time a vial containing this wonderful liquor, but that it was given to him, and afterwards taken away from him.

In addition to the panacea and alcaheſt, Paracelſus, declared himſelf poſſeſſed of the philoſopher's-ſtone. Thus he perſuaded the greater part of his cotemporaries that he was poſſeſſed of what they conceived the two greateſt bleſſings man can enjoy, the unlimited power of encreaſing his wealth and prolonging his life. Againſt the truth of an opinion ſo generally entertained by his cotemporaries, we ſhall offer but one objection. Paracelſus at the latter end of his life wandered about Europe in poverty, and died at the age of 48, to the diſgrace of his boaſted aurum potabile, azophs, little demons, elixers, and immortal catholicons, after a few days ſickneſs at a public inn at Saltzburg, although he had flattered himſelf that by the uſe of his *elixer proprietatis* he ſhould live as long as Methuſelah.

The failure of Paracelſus did not intimidate others from purſuing the chimera, among the number, Caſſius, known by his precipitate of gold; Libavius, whoſe name is affixed to a preparation of tin; Sir Kenelm Digby, who believed in the ſympathetic action of medicaments; Van Helmont famous for his medical opinions and chemical notions; and Borrichius a Daniſh chemiſt, who firſt diſcovered the method of inflaming the oils by the nitric acid, are particularly to be noticed for their talents. To the labours of theſe men we are indebted for many valuable medicines. But in a peculiar manner they demand our gratitude for the intimate union they have produced between medicine and chemiſtry, the conſequence of which has been that diſeaſe has been ſtripped of half its terrors.

Amid the dark gathering clouds of ignorance and ſuperſtition, that hung over all Europe during this century, one ray of light burſt forth ſo pure and ſtrong as to indicate a rapid diſperſion of the worſe than Egyptian darkneſs of the age. Francis Bacon, a name that muſt at once draw forth our pity and admiration, appeared at the latter end of the ſixteenth century, and laid the foundation of natural philoſophy on the true and immutable baſis of reaſon. For ſome centuries paſt the world had been engaged not in diſcuſſing philoſophical truths, but the opinions of philoſophers.

The book of Nature, from whence alone true knowledge can be drawn, was entirely neglected, and the works of Ariſtotle and Plato were made uſe of to ſupply its place. Inſtead of endeavouring to diſcover her laws by obſerving their effects, they attempted to explain them by the *categories* of the Peripatetics or the *ideas* of the Platoniſts. But Bacon, perceiving that theſe *ignes fatui* only ſerved to lead aſtray, choſe for his guide the invariable light of reaſon. By this he ſoon perceived that a knowledge of the laws of Nature can only be acquired by obſerving her operations. He therefore adviſed mankind, inſtead of ſpending their time in interpreting the idle dreams of myſtical philoſophers, to forſake their air-built caſtles and by experiment erect their ſyſtems on the adamantine baſis of truth. Not content, like the generality of reformers, with barely pointing out the road they ought to purſue, this able pioneer proceeded a conſiderable diſtance in it, and cleared the way to many of the greateſt diſcoveries of his ſucceſſors. But either from that love of unintelligible ſyſtems which is ſo common in ignorant men, or, from a dread of entering on a new road, the termination of which they could not perceive, it was ſome time before mankind could be drawn from the beaten track.

About this time Glauber, a German, rendered eſſential ſervice to chemiſtry, by examining the reſidues of operations which had heretofore been thrown aſide as uſeleſs and diſtinguiſhed by the names of *caput mortuum*, or, *terra damnata*. By this he diſcovered the *ſulphat of ſoda*, called after him Glauber's ſalts, the *ſulphat of ammoniac ;* and threw great light on the proceſſes for preparing the mineral acids.

At the commencement of the ſeventeenth century the alchemical mania arrived at its acme. In Germany a ſociety was formed under the name of the Roſicrucians, of which little more is known than that they pretended to be in poſſeſſion of the ſecrets of tranſmutation, of the univerſal ſcience and medicine, with the ſcience of occult things. In France, England, Spain, and moſt of the other nations of Europe, the belief in alchemy was carried ſo far that decrees were iſſued by government forbidding it to be practiſed, leſt the value of the current coin of the nation ſhould be deſtroyed, or individuals practiſing it be rendered too powerful.

This triumph of error over reaſon, like every other triumph of the ſame nature, was, however, doomed to have an end. Father Kircher, a Jeſuit, author of a great work entitled "*Mundus Subterraneus*," and Corringius, a learned phyſician, commenced an attack on it, which, by the aid of the philoſophical chemiſts who made their appearance ſome years after, totally deſtroyed this chemical monſter.

Chemiſtry had hitherto conſiſted of a multitude of facts, diſſeminated without any regard to arrangement over many looſe diſſertations on its various objects. "As yet," as Macquer obſerves, "there "were many branches of chemiſtry in being, though "the ſcience itſelf was not yet in exiſtence." Towards the middle of the ſeventeenth century James Barnet, phyſician to the king of Poland, firſt collected and arranged the principal known facts in a methodical manner, and added obſervations thereon. Bohnius, profeſſor at Leipſic, likewiſe formed a methodical collection. But Joachim Becher of Spires wrote a work entitled "*Phyſica Subterranea*," which from the preciſion with which the facts are related, and his obſervations on them, ſo far eclipſed the writings of Barnet and Bohnius that their works are now totally neglected, and their names almoſt forgotten. This work, in which there are a number of conjectures verified by late diſcoveries, had the honour of having for a commentator one of the brighteſt ornaments chemiſtry can boaſt—I mean the celebrated Stahl.

George Erneſt Stahl was born at Onold in Franconia, in 1660. From his earlieſt youth he appears to have been attached to the ſtudy of chemiſtry. But in a particular manner his mind was directed to aſcertain the true principle of inflammability.

Until the time of Becher, the moſt vague notions were entertained on this ſubject, the chemiſts ſuppoſing it to be a *ſulphur* pervading all inflammable bodies. Becher, perceiving that ſulphur did not exiſt in many animal and vegitable ſubſtances, although inflammable, aſſerted that it was not the principle of inflammability, but that this principle reſided in a ſubſtance common to ſulphur as well as all other inflammable bodies; this ſubſtance he ſuppoſed to be of a *dry* nature, and therefore called it an *earth*, and to diſtinguiſh it from all other earths, he called it PHLOGISTON. This doctrine was adopted by Stahl, who ſo far improved and extended it, that he is now generally conſidered as its founder.

The human mind delights in ſpeculative reaſoning. It can ſcarcely receive two connected facts without wiſhing to draw a general concluſion. It is this ſpirit of generalization, which has given birth to ſome of the moſt ſublime as well as the wildeſt theories. Without it the mind of man would be nothing better than a wild chaos of facts. Inſtead of a well conſtructed temple, throughout the whole of which reigns the moſt perfect harmony, it would be a mere quarry in which although all the materials for conſtructing the temple are contained, yet they are in ſo rude and deranged a ſtate that they are neither uſeful nor elegant. The aſſent of mankind, it is true, is often obtained to the wildeſt theories; yet even theſe, falſe as they may be, ſerve the purpoſe of giving ſome ſort of arrangement to all the known facts, and any arrangement, however bad, is better than none. Nor need we be afraid that any falſe theory, however ſpecious it may appear, will be permanent; for, WHATEVER SYSTEM IS NOT FOUNDED IN TRUTH MUST FALL!

As ſoon then as Becher's doctrine of phlogiſton, as improved by Stahl, became generally known, it was adopted by the undiſſenting voice of the chemical world. It anſwered for the limited ſtate of chemical knowledge, and the philoſophers from his time until within a few years paſt knew of no phænomena in combuſtion that they could not account for ſatisfactorily, *to themſelves*, by this theory.

About this time lived Mayow, an Engliſh phyſician, famous for a number of *ingenious conjectures.* According to Dr. Haller, he ſuppoſed that *nitre* floating in the air was abſorbed into the lungs and formed the *animal ſpirits*, the heat of the ſyſtem, and imparted colour to the blood. Blumenbach ſays he was one of the firſt authors who wrote concerning the factitious airs eſpecially that now called *dephlogiſticated air*, or *oxigene*, the "*ſpriritus nitri aerius*" of Mayow. The work which contains his peculiar notions on this ſubject is entitled "*Tractatus duo: de reſpiratione, et de rachitide.*" publiſhed at Oxford in 1668. He was but 34 years of age when he died.

We are now entering on the moſt brilliant era that has ever occurred in this ſcience. Hitherto the progreſs of chemiſtry had been ſlow and uncertain. It depended on accidental diſcoveries made in ſearch of chimerical objects. Its votaries were not led on ſo much by the love of truth as the love of life and wealth. But the theory of Becher and Stahl gave a new direction to the purſuits of chemiſts, and inſtead of the philoſopher's ſtone, alcaheſt and panacea, their labours were now directed to the eſtabliſhment of a theory of combuſtion.

Stahl, whoſe mind was entirely occupied with demonſtrating his favourite theory, and obſerving all the ſuppoſed modifications of phlogiſton, ſeems to have overlooked the influence of air in all the phænomena which he attributes to his inflammable principle. The neceſſity of attending to this fluid in the operations of chemiſtry had already been demonſtrated by Boyle and Hales. The difference between chemical events that happen in like circumſtances in air and vacuo had been obſerved by the former, and the latter had procured from various ſubſtances different kinds of air. He thought air was the cauſe of ſolidity in bodies.

Dr. Prieſtley, in purſuing the experiments of Hales, diſcovered many elaſtic fluids which had heretofore been entirely overlooked by the chemiſts. Dr. Hales had obtained air from *minium*, but he had not inveſtigated its properties. On the firſt of Auguſt 1774, a day which will ever be conſpicuous in the annals of ſcience, Prieſtly obtained this air*, and found it much purer than atmoſpheric air. In the courſe of ſome experiments he inſtituted on this air, he found it to be the cauſe of the red colour acquired by the blood in paſſing through the lungs. This diſcovery has laid the foundation of a theory of animal heat that has thrown more light on the ſcience of phyſiology than perhaps any other diſcovery ever made.†

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* Called by him *dephlogiſticated air*, from his ſuppoſing it to be air deprived of all phlogiſton, and by the French chemiſts *oxigene*, from its being the principle of acidification.

† See note on combuſtion.

Mr. Lavoiſier ſoon after proved that the weight acquired by heated bodies is owing to an abſorption of oxigene.* To this diſcovery we are indebted for the French ſyſtem of chemiſtry.

Before entering on this revolution, the greateſt perhaps that has ever occurred in this or any other ſcience, you will pardon me for occupying a few minutes of your time in paying the debt of gratitude we owe to him by whom it was effected.

Lavoiſier was born at Paris, Auguſt 16th, 1743. From his earlieſt youth he manifeſted a genius of no common order. At the age of three and twenty he obtained from the Academy of Sciences a gold medal for a diſſertation on the beſt mode of enlightening during the night the ſtreets of a great city. Two years afterwards he was made a member of that juſtly celebrated ſociety. As yet his mind was confined to no particular branch of ſcience, but each in its turn was benefited by his attention. Until at length, about 1770, Lavoiſier, ſtruck with the importance of the diſcoveries which had recently been made by Prieſtley, Black,† Cavendiſh and Macbride, relative to elaſtic fluids, turned his attention to this inexauſtable ſource of diſcovery. He had now entered on a career which was to rank his name with thoſe of Bacon, Newton and

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* See note B.

† In 1755 Dr. Black diſcovered *fixed air* or the *carbonic acid* in *calcareous earth*. He affirmed that the diſſipation of this air converts it into *lime*, and that by reſtoring it again to the *lime*, *calcareous earth* is regenerated.

Hartley. His time and fortune were devoted to furthering diſcoveries in chemiſtry, and his houſe became a great laboratory filled with every ſpecies of apparatus neceſſary in this ſcience. Here he made welcome men of ſcience to whatever nation they might belong, or to whatever opinions they might be attached. Twice a week he held aſſemblies at his houſe, to which was invited every perſon moſt eminent in geometrical or phyſical knowledge. Here all the new chemical opinions which appeared in Europe were diſcuſſed and teſted by experiment. Before this aſſembly Lavoiſier tried all his experiments, and liſtened with candour to the diſcuſſion of them. To this line of proceeding we are indebted for that accuracy of experimenting, which has been introduced, inſtead of the former incorrect mode. After his experiments and theories had paſſed this ſtrict ordeal, and not before, he gave them to the world.

It is to theſe aſſemblies we are indebted for the new nomenclature, which the French chemiſts have introduced into this ſcience. This nomenclature has tended conſiderably, by baniſhing much of the technical jargon of chemiſtry, to its promotion, and leaves nothing for us to wiſh, but that they who made ſo happy a commencement had extended it ſtill farther. We may conſider it as a happy omen of what we are to expect from an introduction of a philoſophical language into the ſciences.*

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* See note C.

The effects of theſe labours of Lavoiſier are to be found in forty memoirs, replete with the grandeſt ideas relative to the various phænomena of chemiſtry, publiſhed by him, from the year 1772 to 1793, in the tranſactions of the French academy. In 1784 he formed an idea of collecting into a ſingle work all the diſcoveries he had given to the world at different periods. This work, which did not appear till 1789, exhibited the ſimplicity of his ſyſtem in ſo forcible a point of view that it ſoon gained the almoſt univerſal ſuffrage of the chemical world.

Hitherto we have beheld Lavoiſier only as the philoſopher, rending the veil of nature, and drawing into view all her native charms. Let us now view him in the no leſs exalted ſtation of private life. If as philoſopher he raiſes our aſtoniſhment by the brilliancy of his diſcoveries and profundity of his reaſonings; as a man he no leſs excites our admiration by his ſtrict performance of all the duties of a friend, a relative, and a citizen. In ſhort, Lavoiſier was one of thoſe truly exalted characters that prove the folly of the obſervation, made by *malicious ignorance*, that a love of ſcience and a performance of the duties of life are incompatible.

Our picture has as yet diſplayed none but the moſt pleaſing colouring—Would to heaven! I could, conſiſtently with my duty put it out of my hands unfiniſhed as it is. But there is one dark ſhade, which to complete it, muſt be laid in, and which will efface the pleaſure ariſing from a contemplation of its beauties.

Lavoiſier was ſtrongly attached to the cauſe of SCIENCE and TRUTH, and conſequently to that of LIBERTY. When the French revolution burſt forth on the aſtoniſhed world, he, therefore, early appeared as its advocate. Until at length Robeſpierre, having *deſcended* from the elevated ſtation of a Repreſentative of the People, to the debaſed one of their Tyrant, perceiving that a love of ſcience and truth naturally produced a love of liberty, determined on the deſtruction of all thoſe who united theſe dangerous qualities. Lavoiſier was one among the many marked out for deſtruction. No other excuſe could be found for his execution, than that he had been a *farmer-general* under the old government: But this excuſe weak as it was, was ſufficient for the *tyrant*, who had the *power* and the *will* to deſtroy him. Let us draw a veil over the fatal cataſtrophe that has deprived the republic of ſcience of its brighteſt ornament.* And while we mourn the loſs of this benefactor of mankind, let us not loſe ſight of the pleaſing hope that he and his *murderer* ſhall be remembered as they deſerve. Yes! let us cheriſh the pleaſing idea, that while the name of Robeſpierre ſhall be remembered with deſerved deteſtation along with thoſe of Nero and Caligula to excite indignation againſt tyranny and its ſupporters, that of Lavoiſier ſhall excite in the breaſt of every votary of ſcience the warmeſt gratitude!

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* When the order for his execution was preſented to Lavoiſier he requeſted a few days to complete a courſe of experiments he had commenced, but this was refuſed and he was hurried off to the *ſcaffold*. What may we not have loſt!

FROM the time of Stahl to that of Lavoiſier the metals were ſuppoſed to be compound bodies, formed by the union of phlogiſton with peculiar earthy baſes. During their combuſtion or calcination they were ſuppoſed to part with this phlogiſton to the ſurrounding bodies. Even the weight they acquired by this ſuppoſed loſs of one of their conſtituent principles did not for a long time ſhake the belief of the followers of Stahl in their favourite theory. They all ſeemed eager to diſcover ſome opiate by which they might lull their reaſon to ſleep. The celebrated Boyle affirmed that the increaſe of weight in calcined metals is owing to the combination of the matter of fire. Boerhaave attributed it to the ſurrounding bodies which depoſite themſelves upon the metal: While the generality of the followers of the doctrine of phlogiſton ſuppoſed it to be the principle of *levity*. Such are the powerful effects produced by the union of a great name with any theory whatever; like the head of a monarch ſtamped upon baſe metal, it ſerves to give it currency for a time among the unobſerving part of mankind.

At length Lavoiſier proved that the increaſed weight of the calx is owing to the abſorption of oxigene, and that it is in the exact proportion of the quantity of this gas abſorbed. He now undertook to reverſe the theory of Becher and Stahl. Inſtead of ſuppoſing that in combuſtion phlogiſton is ſeparated from the combuſtible body, he accounted for this phænomenon by the body abſorbing oxigene from the atmoſphere, which he diſcovered conſiſted nearly of twenty-eight parts of oxigene united to ſeventy-two of nitrogene.

The ſupporters of the doctrine of phlogiſton, thinking it in vain to attempt any longer to uphold a ſyſtem founded on the exiſtence of ſo chimerical a ſubſtance as they had heretofore deſcribed, and perceiving that in many caſes of the ſolution of metals in acids inflammable air is generated, declared this hydrogenous gas to be phlogiſton in an uncombined ſtate. No ſooner had they given to this

> ——————————" airy nothing
> " A local habitation and a name,"

than they doomed it to deſtruction. While it retained its *Protean* powers of at one time being the principle of levity, and at another poſſeſſing gravity, it was impoſſible to graſp it firmly enough to deſtroy it; but it now became a fair object of diſcuſſion.

The French chemiſts were for ſome time at a loſs to account for this diſengagement of hydrogene. At length Mr. Cavendiſh diſcovered that water is a compound body, formed by the union of the baſis of hydrogene and oxigene. The ſource from whence the inflammable air ariſes now evidently appeared not to be, as their opponents ſuppoſed, from the metal during ſolution parting with its phlogiſton, but from the water combined with the acid being decompoſed, its oxigene uniting to the metal whilſt its hydrogene is ſet at liberty.

Lavoiſier has applied his theory of the calcination of metals to the phœnomena of every other ſpecies of combuſtion with ſo happy an effect that the doctrine of phlogiſton has become almoſt univerſally exploded.* That theory, which but a few years ſince commanded the undiſſenting voice of the chemical world, is now almoſt totally forſaken. Still however the tottering dome of this once mighty fabric is ſupported by one ſolitary pillar, ſo well conſtructed, as by its ſingle force to uphold it againſt the warring elements, nor can it ever fall till this pillar is removed—Never can the doctrine of phlogiſton be ſaid to be totally deſtroyed, until it ſhall ceaſe to rank among its ſupporters the name of PRIESTLEY!

I ſhall now preſent you with the laſt and moſt pleaſing revolution that has occurred in chemiſtry. Hitherto we have beheld this ſcience entirely in the hands of *men*; we are now about to behold *women* aſſert their juſt, though too long neglected claims, of being participators in the pleaſures ariſing from a knowledge of chemiſtry. Already have Madam Dacier and Mrs. Macauly eſtabliſhed their rights to criticiſm and hiſtory. Mrs. Fulhame has now laid ſuch bold claims to chemiſtry that we can no longer deny the ſex the privilege of participating in this ſcience alſo*. What may we not expect from ſuch an acceſſion of talents? How ſwiſtly will the horizon of knowledge recede before our united labours? And what unbounded pleaſure may we not anticipate in treading the paths of ſcience with ſuch companions?†

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* See Note D.

I ſhall now, gentlemen, conclude with a few obſervations on the utility of a general diffuſion of chemical knowledge throughout America.

Living as we do in a new, extenſive and unexplored country, ſeparated by an immenſe ocean from all other civilized nations, we muſt feel ourſelves deeply intereſted in a knowledge of *its* mineral productions, and this can only be arrived at through the medium of chemiſtry. As far as our very limited knowledge has yet gone, we have every reaſon to believe that nature has been far from beſtowing her bleſſings on it with a parſimonious hand. Abounding as it does with the richeſt ores of the moſt valuable metals, we ſhould be committing a crime of the blackeſt dye, were we through *wilful ignorance* to trample under our feet theſe invaluable gifts of the CREATOR.

The only true baſis on which the INDEPENDENCE of our country can reſt are AGRICULTURE and MANUFAC-

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* Mrs. Fulhame has lately written an ingenious piece entitled "An "Eſſay on Combuſtion, with a view to a new art of dying and painting, "wherein the phlogiſtic and anti-phlogiſtic hypotheſes are proved erro"neous." Since the delivery of this oration ſhe has been elected a correſponding member of this ſociety.

† See note E.

TURES. To the promotion of theſe, nothing tends in a higher degree than chemiſtry. It is this ſcience which teaches man how to correct the bad qualities of the land he cultivates by a proper application of the various ſpecies of manure, and it is by means of a knowledge of this ſcience that he is enabled to purſue the metals through all the various forms they put on in the earth, ſeparate them from ſubſtances which render them uſeleſs, and at length manufacture them into the various forms for uſe and ornament in which we ſee them. If ſuch are the effects of chemiſtry, how much ſhould the wiſh for its promotion be excited in the breaſt of every American! It is to a general diffuſion of a knowledge of this ſcience, next to the VIRTUE of our countrymen, that we are to look for the firm eſtabliſhment of our INDEPENDENCE. And may your endeavours, GENTLEMEN, in this cauſe, entitle you to the gratitude of your FELLOW-CITIZENS.

# NOTES.

### NOTE A—p. 15.

THE origin of alchemy cannot be traced farther back with any certainty than the ſecond or third century of the chriſtian era. In all probability it owed its birth to the general adoption of the propoſition that "*All bodies are but different modifications of the ſame primitive matter*"...the philoſophers ſuppoſing that this modification might be changed at pleaſure by means of certain chemical agents.

### NOTE B—p. 27.

"Rey, in the laſt century, aſcribed the increaſed weight of metallic "ſubſtances when they are ſaid to have loſt their phlogiſton, to its true "cauſe, the abſorption of air, but on ſuch weak grounds that he is as little "entitled to the honour of a diſcoverer, as a ſucceſsful dreamer is to "that of a prophet; nor can I with juſtice aſcribe this honour to Dr. "Hales, though he extracted air from minium; as he imputed the in"creaſe of weight not only to the air, but alſo to ſulphur which he ima"gined is abſorbed from the fire."

*Kirwan on Phlogiſton.*

### NOTE C—p. 28.

The almoſt innumerable technical terms which had been introduced into chemiſtry, before the formation of the new nomenclature, had for a long time been a cauſe of general complaint among chemiſts. The ſame ſubſtance had often eight or ten different names applied to it, moſt of which either conveyed no idea of its properties, or what is ſtill worſe, indicated very oppoſite ones to thoſe it poſſeſſed. Within the little time that elapſed from Dr. Black's diſcovery of carbonic acid it had been known by the names of *Fixed Air*, *Aerial Acid*, *Mephitic Acid*, *Cretaceous Acid*, *&c.*; but the terms *Oil of Tartar by the Bell*, *Oil of Vitriol*, *Butter of Antimony*, *Butter of Arſenic*, *Flowers of Zinc*, *&c.* as applied to theſe ſeveral compoſitions, are ſtill worſe, as they ſerve not only to burden our memories with a uſeleſs quantity of words, but to give us a falſe idea of the nature of the ſubſtances they are put for; as there does not exiſt in the mineral kingdom, properly ſpeaking, either *Butter, Oil, or Flowers.* A reform in the chemical nomenclature became therefore abſolutely neceſſary to the promotion of ſcience, or rather it became neceſſary, where ſo much error exiſted, to pull down the old ſyſtem and erect a new one.

In 1782 M. de Morveau propoſed a reformation of the nomenclature, and in 1787, M. Lavoiſier, by the aſſiſtance of many of the beſt chemiſts of France, produced the following excellent plan, which is now generally adopted.

1. All thoſe ſubſtances which cannot be ſeparated into two or more different principles, by any known proceſs, although they *may be* compound bodies, yet are to be conſidered, until an analyſis can be made, as elementary, and names given to them indicating their principal properties: thus the baſis of vital or pure air is called *oxigene* from the Greek words OXUS, *acid*, and GEINOMAI, *I beget*, as by a union of this ſubſtance with certain baſes all the acids are formed; and the baſis of *inflammable air* is called *hydrogene* from the Greek words UDOR, *water*, and GEINOMAI, *I beget*, as it is by a union of this ſubſtance with oxigene that water is formed.

2. When two ſimple ſubſtances are united, the name of the compound is to be ſo formed, by a general rule, as at once to convey the ideas of its conſtituent principles.

Thus all the combinations of thoſe metals with oxigene, which do not by ſuch an union form acids, are called by the general names of *oxides*, as in the caſe of the union of oxigene with lead forming red-lead; which, according to the new nomenclature, is called *oxide of lead*.

According to the new theory the acids are all formed by the union of oxigene with certain baſes, the names of the acids are therefore all made by giving to the names of their baſes, where they are known, or when their baſes are not known to the name of the ſource from whence they are derived, the general termination *ic*. Thus that acid formed by the union of oxigene and ſulphur is called the *ſulphuric acid*, and the acid procured from the *Fluor Spar*, the baſis of which is unknown, is called the *fluoric acid*: But there are acids the baſes of which are not fully ſaturated with oxigene, theſe are diſtinguiſhed by the termination *ous*, thus when *ſulphur* is not quite ſaturated with oxigene it is called the *ſulphureous acid*.

3. The neutral ſalts are all formed by the union of the different acids with alkaline, earthy or metallic baſes. Their names are made by a union of the names of the acids of which they are compoſed terminating with *at* when they are perfect acids, or fully ſaturated with oxigene, and *ite* when they are imperfect, and the names of the baſes to which they are united. Thus Glauber's ſalts, which are formed by the union of the *ſulphuric acid* and *ſoda* are called *ſulphat of ſoda*, and a combination of the *ſulphureous acid* and iron, is called *ſulphite of iron*.

In favour of this theory of a nomenclature, little need be ſaid, as it bears internal evidence of its utility. Of the immenſe quantity of technical words which are ſaved by it I ſhall give the ſingle inſtance of the neutral ſalts.

There are at preſent 30 acids known, capable of forming neutral ſalts by their union with three alkalies, eight earths, and fourteen metals, in all 25 baſes, which would make 750 different neutral ſalts. If to theſe we add thoſe which could be formed by many of theſe acid in a ſtate not fully ſaturated with oxigene, we ſhall have not far ſhort of 1,000 different neutral ſalts. Allowing the former arbitrary mode of naming them to prevail, there can be no doubt that each of theſe ſalts on an average would have in the courſe of time at leaſt two names, we ſhould then have 2,000 names for them. But happily for the cauſe of ſcience our memories are ſaved from being oppreſſed by this immenſe maſs of technical rubbiſh by the proper application of the third rule.

For a full account of this nomenclature ſee the memoirs of Meſſrs. Lavoiſier, De Morveau, Bertholet, De Fourcroy, Haſſenfratz, and Adet; firſt publiſhed in the tranſactions of the academy of Science in Paris, in 1787, and ſince tranſlated into Engliſh and publiſhed by Mr. St. John.

*Query*. Might not the nomenclature be extended to all combinations of two ſimple earths by uſing the name of the earth found in the greateſt quantity as a *ſubſtantive*, and that of the one found in the leaſt quantity as an *adjective*. Thus a ſtone formed by the union of a ſmaller quantity of *ſilex* united to a greater quantity of *alumine* would be called a *ſilicious alumine*, whereas if the *ſilex* predominated it would be an *aluminous ſilex*. It might perhaps, be alſo applied to the union of a ſimple earth with a neutral ſalt, as in marble, which is compoſed of *alumine* and *carbonate of lime*, which would then be called *aluminous carbonate of lime*?

### NOTE D.—p. 33.

Lavoiſier inſtead of ſuppoſing with the diſciples of Becher and Stahl, that all inflammable bodies poſſeſs a certain principle, which they called *phlogiſton*, the giving out of which cauſes all the various phœnomena of combuſtion, ſays that they entirely ariſe from the decompoſition of *oxiginous gas*, which is a compound body formed by the union of a certain baſis with the matter of heat and light,—the baſis uniting to the inflammable body while its caloric or matter of heat, and light are ſet at liberty. This theory they found upon the following principles.

1. Combuſtion is never *known* to take place without the preſence of oxigene.

2. In every *known* combuſtion there is an abſorption of oxigene.

3. There is an augmentation of weight in the products of combuſtion equal to the weight of the *oxigene* abſorbed.

4. In all combuſtion there is a diſengagement of light and heat.

I ſhall here take the liberty of ſuggeſting the following *queries*.

QUERY 1. Should we not conſider combuſtion as an effect of the *elective attraction* between the baſis of the gas and the combuſtible body being ſtronger than that between the ſame baſis and caloric?

QUERY 2. If ſo, would not the ſame phœnomena take place were we to heat a body in any other gas whoſe baſis has a ſtronger elective attraction to the body than to caloric and light, as do when ſuch bodies are heated in oxigene?

QUERY 3. In the combuſtion of hydrogene with oxigene do we not find this to take place? Does not the baſis of the hydrogenous gas, which was retained in a gaſeous ſtate by its union with caloric and light, unite with the baſis of the oxiginous gas, and form water, and at the ſame time part with its matter of heat and light?

Query 4. Should we conclude becauſe thoſe ſubſtances which burn the readieſt in oxigene will not burn in any other gas, that no ſubſtances are to be found that will? Ought we not on the contrary to ſeek theſe ſubſtances among thoſe which do not burn at all, or very ſlowly in this gas, as the probability is that the ſame ſubſtance, which has a very ſtrong elective attraction to the baſis of one gas, will have but a ſlight one to that of every other?

Respiration may be conſidered as a ſlow ſpecies of combuſtion. The oxigene of the atmoſpheric air inhaled is decompoſed, its baſis unites to the blood, through the coatings of the blood veſſels in the lungs, and gives it a red colour, while its matter of heat is ſet at liberty and forms the animal heat of the ſyſtem.

### Note E.—p. 34.

The following ſhort extract ſets chemiſtry, as a proper ſtudy for females, in ſo forcible and juſt a point of view that I cannot refrain from the pleaſure of inſerting it.

"Chemiſtry is a ſcience particularly ſuited to women, ſuited to their "talents and their ſituation; chemiſtry is not a ſcience of parade, it "affords occupation and infinite variety; it demands no bodily ſtrength, "it can be purſued in retirement; it applies immediately to uſeful and "domeſtic purpoſes; and whilſt the ingenuity of the moſt inventive "mind may be exerciſed, there is no danger of inflaming the imagination; the judgment is improved, the mind is intent upon realities, "the knowledge that is acquired is exact, and the pleaſure of the purſuit "is a ſufficient reward for the labour.

*Letters for literary ladies.*

THE END.

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